MOLTECH
CORPORATION

Advances in Lithium-Sulfur Rechargeable Batteries

Powering the Electronic Future

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CORPORATION

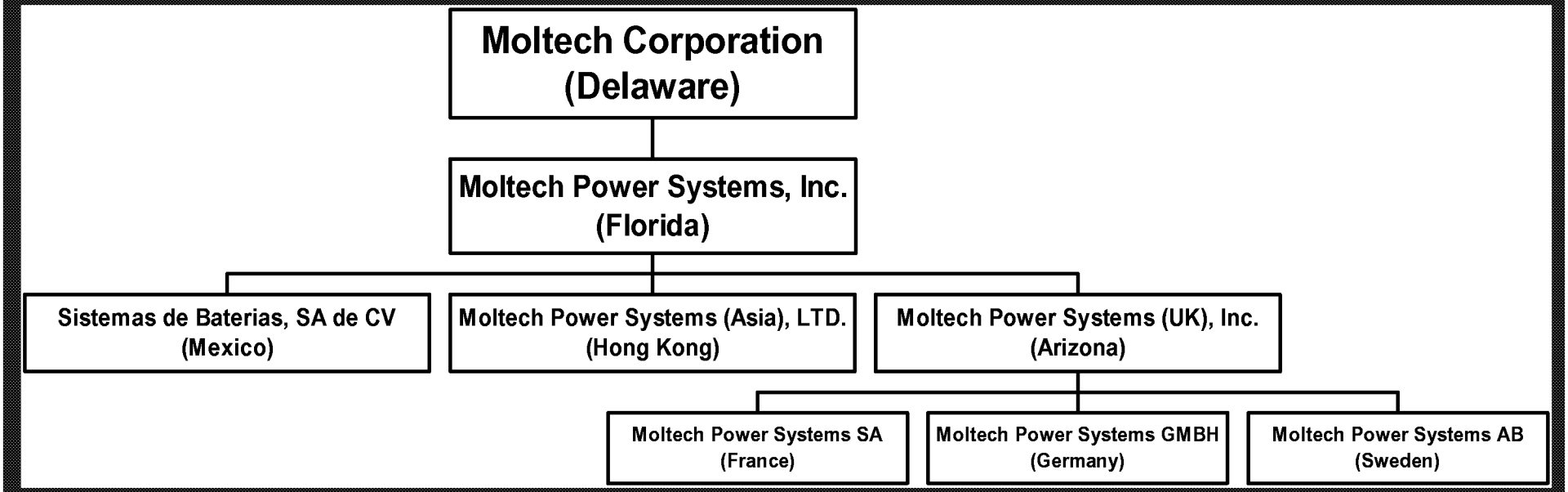
Corporate Overview

Moltech's Mission

- To be the leader in Energy Storage Products

Moltech Corporate Offices, Tucson, Arizona

Corporate Structure



Moltech Corporation History

1988	Founded by Dr. Terje Skotheim as a spin-off from the Brookhaven National Laboratory
1994	First venture capital funding
1995	Signed development agreements with Ericsson, Atlas-Copco and Electrolux
1998-99	Development of Lithium Sulfur (Li-S^{TM}) sample cells

Moltech Power Systems History

1962	General Electric begins NiCd business in Gainesville, FL
1987	Gates Rubber acquires GE rechargeable business
1993	Eveready acquires Gates Nickel rechargeable business
Apr 99	Eveready decides to sell Energizer Power Systems (EPS)
Nov 99	Moltech acquires Energizer Power Systems and Energizer acquires equity in Moltech

Moltech Operating Structure

Gainesville, Florida
Corporate Headquarters
North & South American Marketing & Sales
NiCd / NiMH / Li-S Cell Manufacturing
NiCd / NiMH R & D
Intelligent Electronics
Development
Employees 675

Tucson, Arizona
Lithium Sulfur R & D
Employees 60

Newcastle-**Under-Lyme, UK**
European Marketing & Sales
Battery Design and Assembly
Employees 70

Juarez, Mexico
Battery Design & Assembly
NiCd / NiMH Cell Formation and Test
Employees 1400

Hong Kong
Asian Marketing & Sales
Battery Design & Assembly
Employees 70

Product Attributes

Rechargeable Li-S Cells

- *2 x Specific Energy vs Li-Ion*
- Lightweight (lithium & sulfur)
- Rate capability exceeds Li-Ion
- Environmentally benign
- Low Material Costs

Technology can be applied to:

- *Primary Batteries*
- *Supercapacitors*

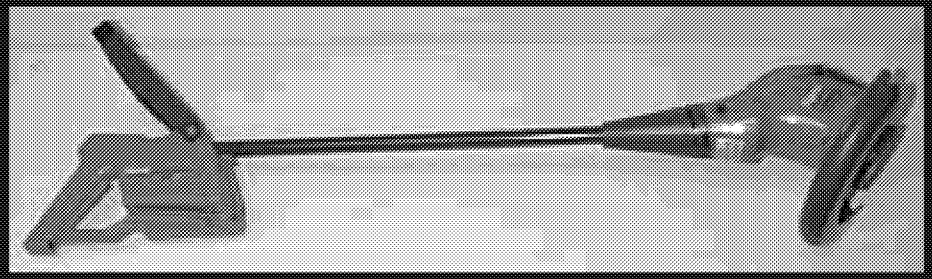
Li-S Adapted Products

Mobile Phones

2.0 – 2.5 Amps

Laptop Computers

3.5 – 6.0 Amps



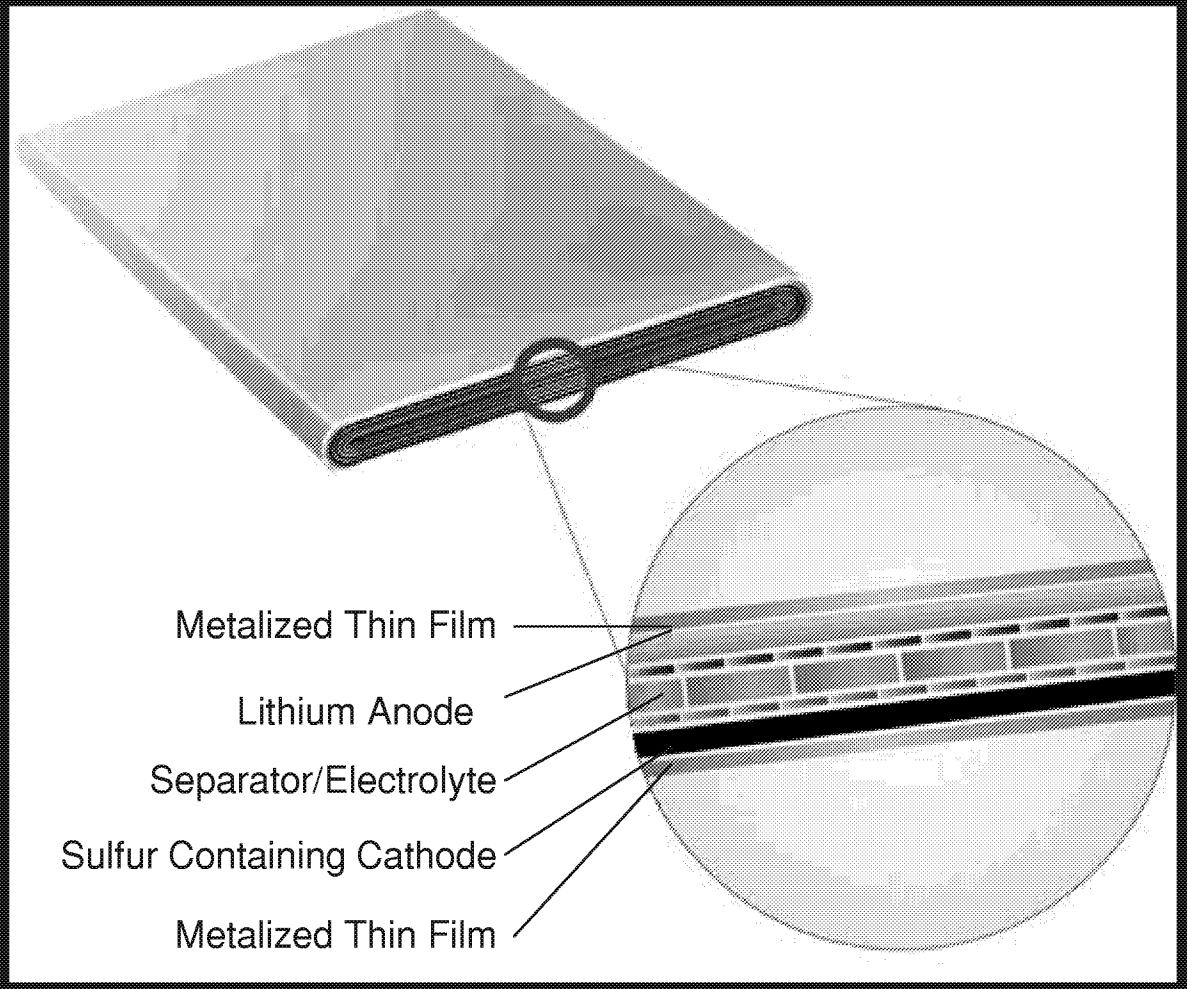
Cordless Grass Trimmer

14 Amps

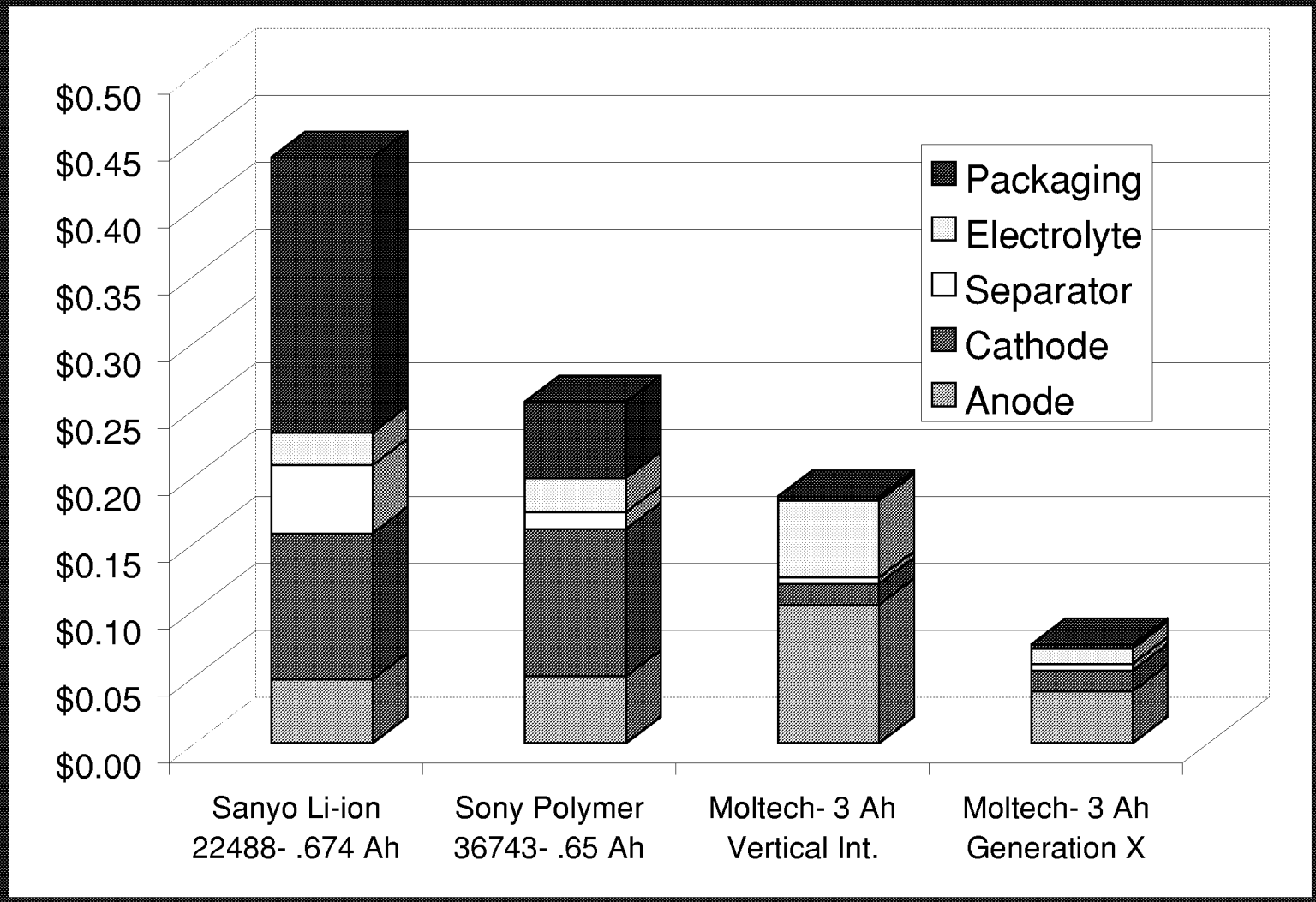
Cordless Drill

20 – 30 Amps

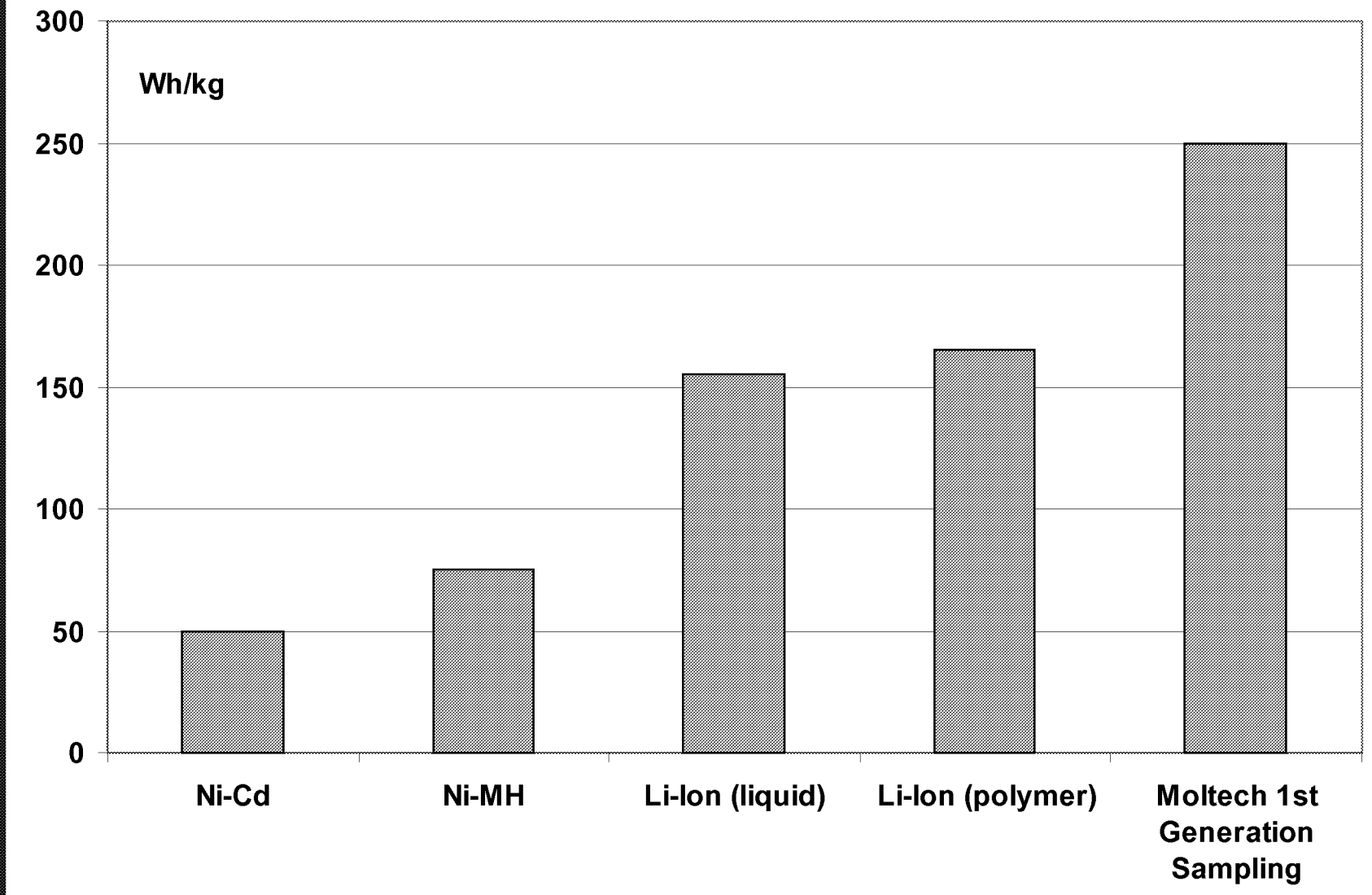
Cell Construction



Low Manufacturing Costs



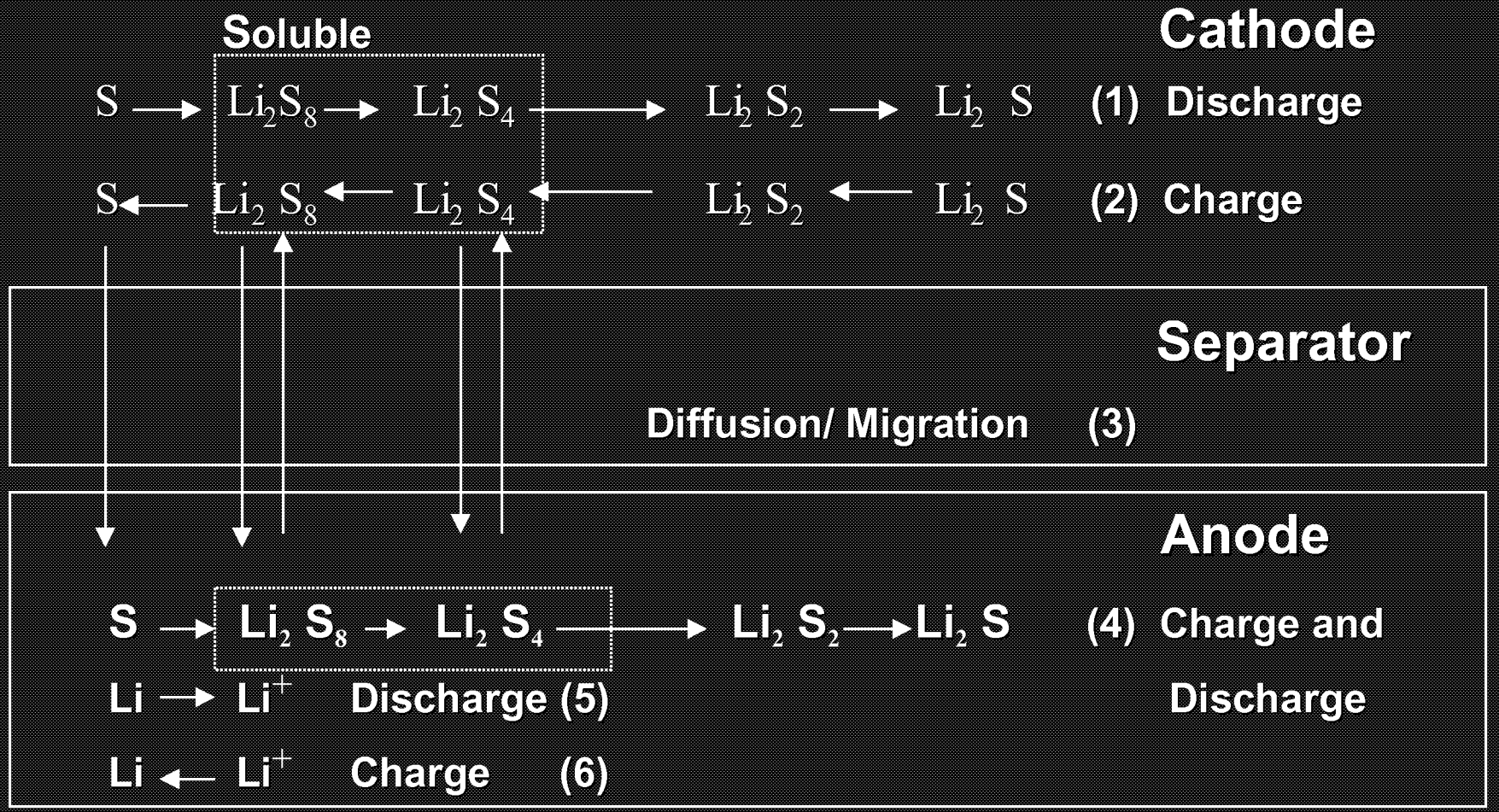
Specific Energy Comparisons



Product Requirements for Second Generation Li-S

- Cycle life to reach 300 at 80% of rated capacity
- Specific energy to 300 WH/Kg
- Volumetric energy to 400 WH/L
- Self-discharge <5%/month
- 70% of ambient capacity @ 1C at -10° C
- 90% of rated capacity at 3C at 25° C
- 80% of rated capacity at 5C at 25° C
- All safety requirements met

Active Materials Transformation Diagram



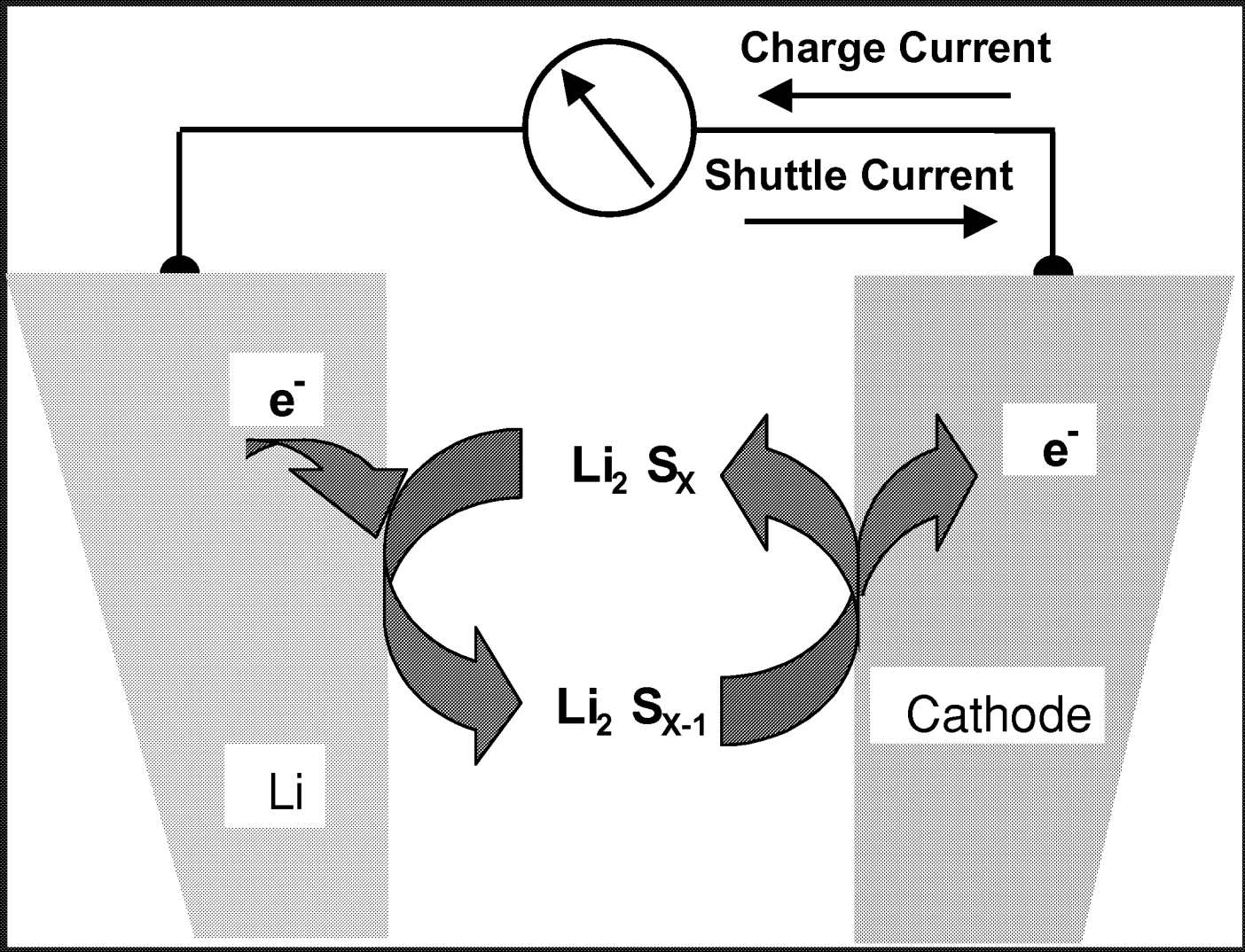
(1) (5) Discharge

(2) (6) Charge

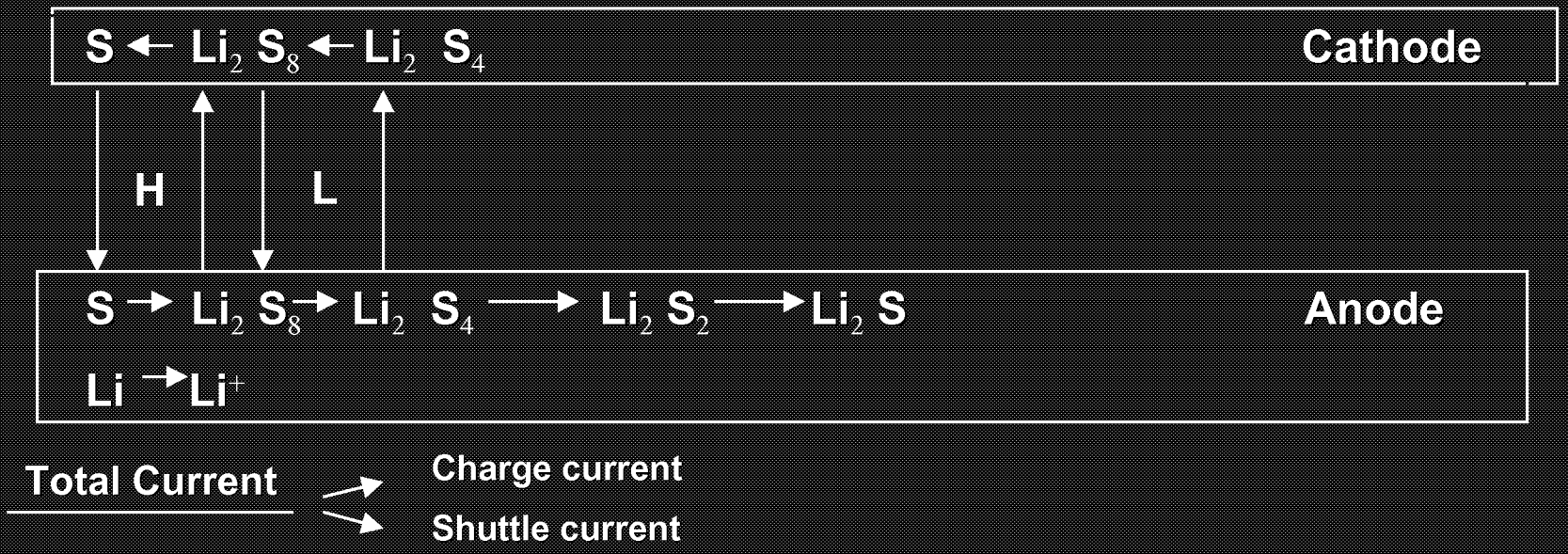
(4+5) (3) Self-discharge

(4+5) (3) (2) Over-charge protection : Shuttle current

Internal Shuttle Protection



Overcharge protection - Shuttle current diagram

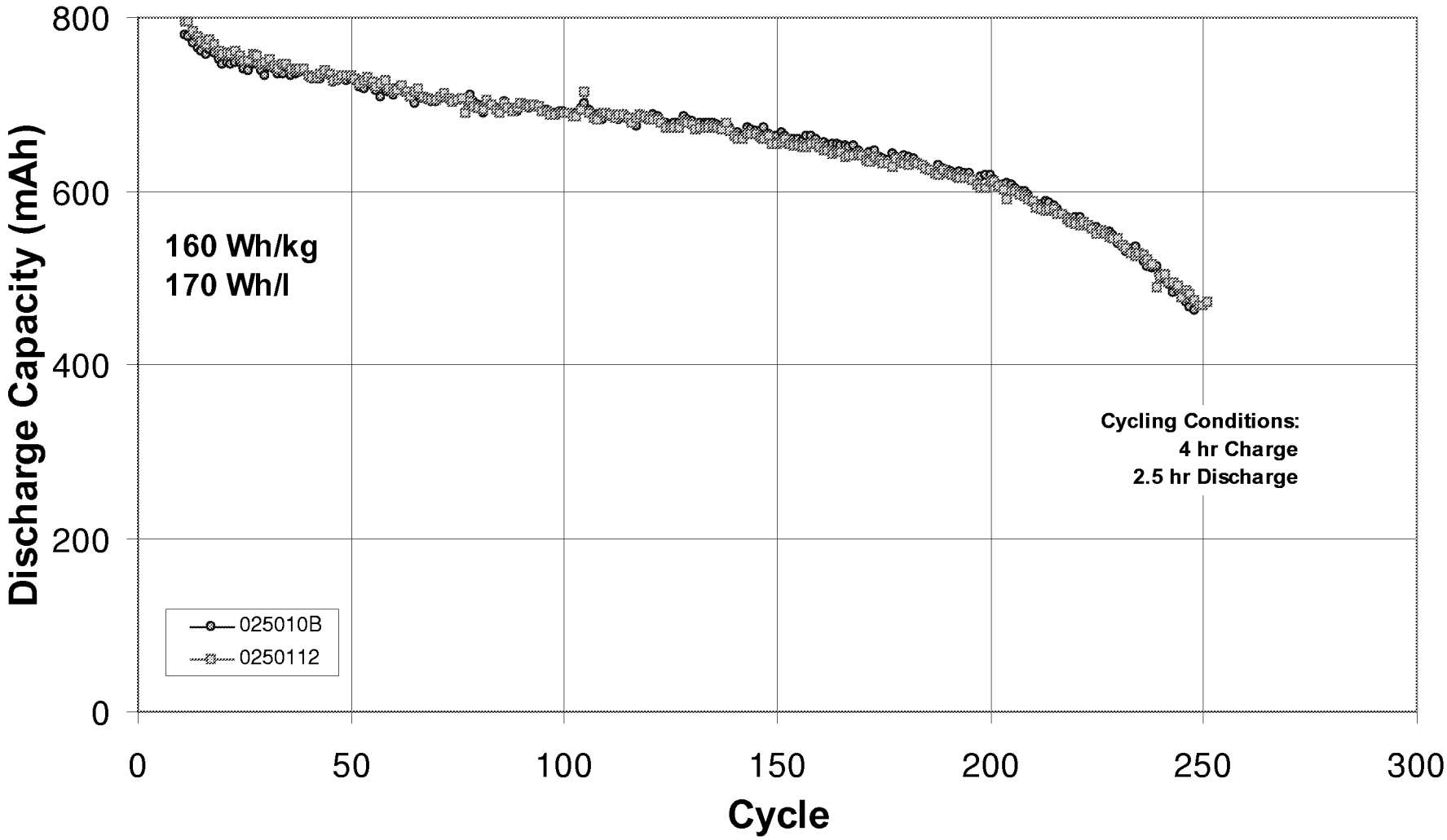


Cycle L	Voltage	
	Shuttle current	~ 0.05 mA/cm^2
	Charge efficiency	95 - 98%

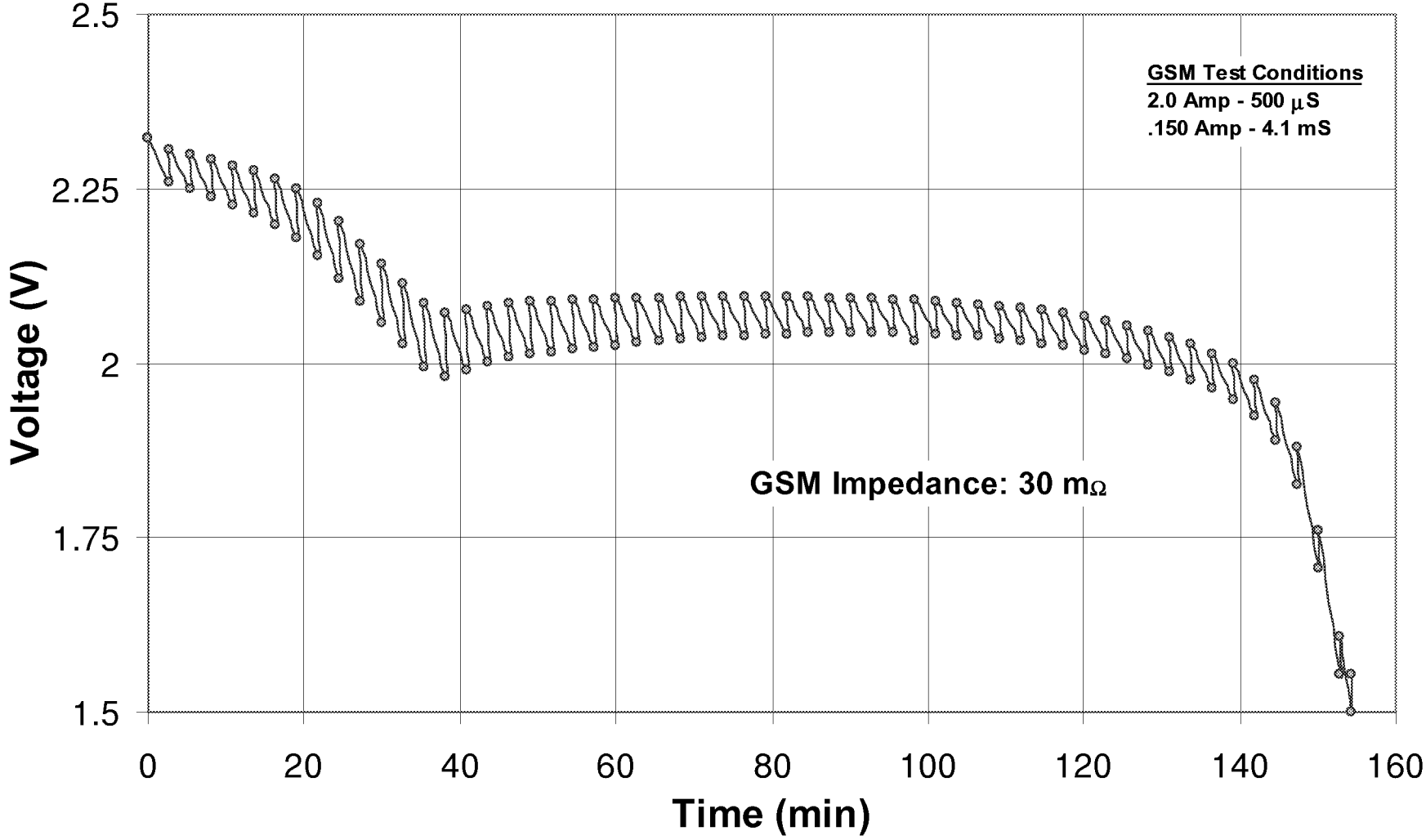
Cycle H	Voltage	2.35 - 2.60 V
	Shuttle Current	0.1 - 0.2 mA/cm^2
	Charge efficiency	40 - 60%

Typical Performance

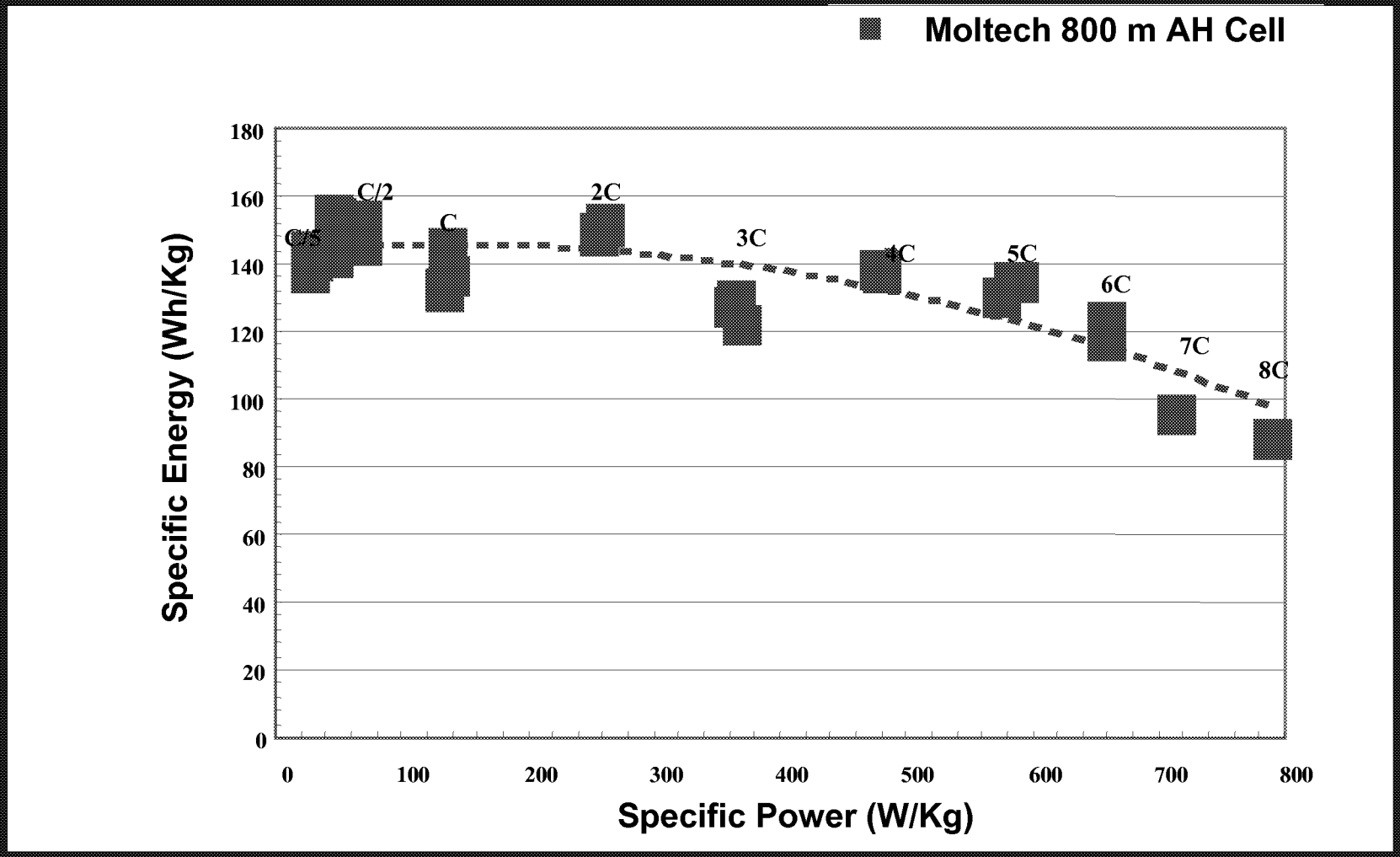
Discharge Capacity vs Cycle Number



Typical Performance
GSM Discharge Profile



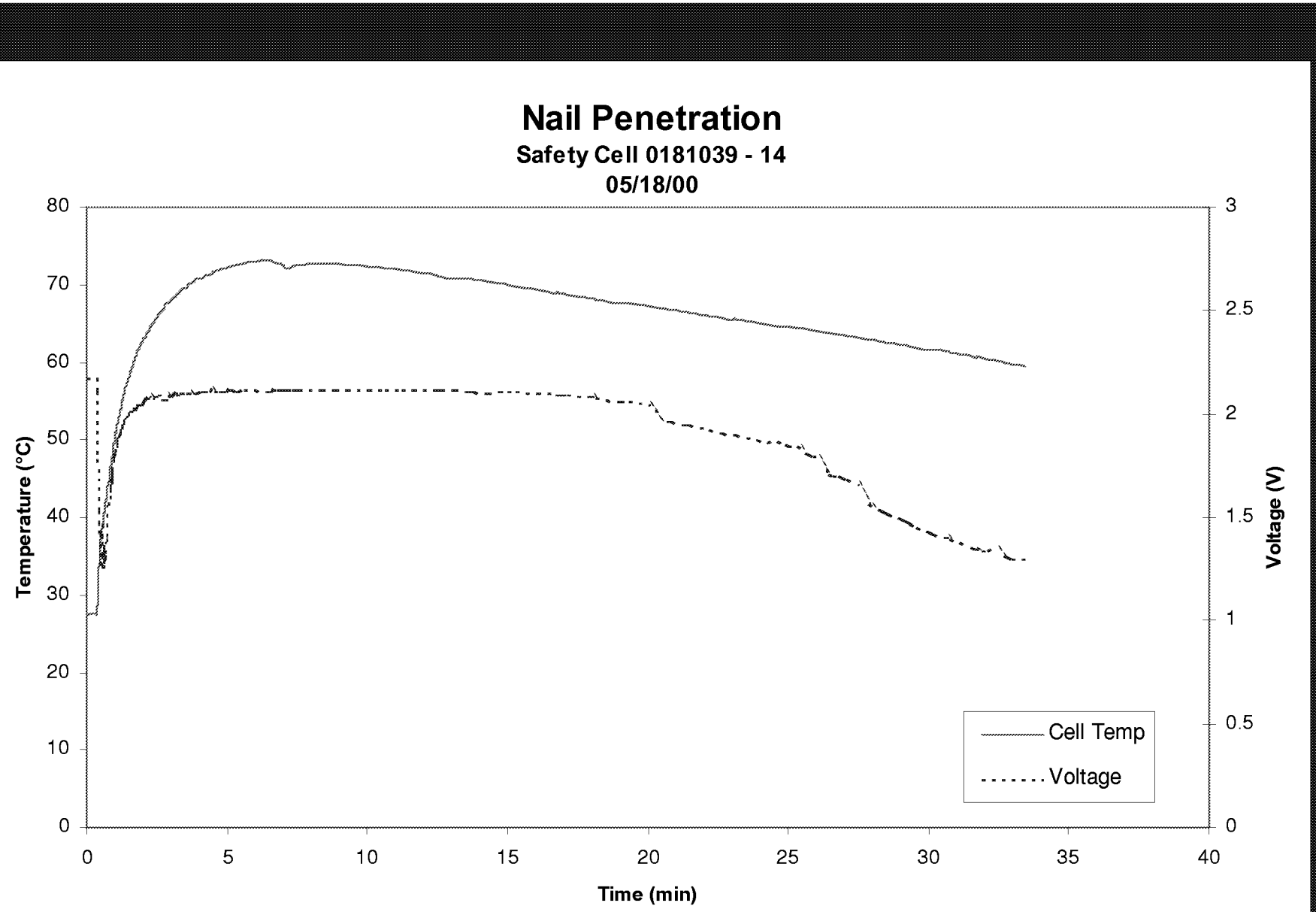
Ragone Plot


Moltech 800 m AH Cell
Specific Energy (Wh/Kg)
180
160
140
120
100
80
60
40
20
0
C/5
C/2
C
2C
3C
4C
5C
6C
7C
8C
0
100
200
300
400
500
600
700
800
Specific Power (W/Kg)

UL 1642 Safety Test Results on Lithium Sulfur Cells
No Safety Circuitry - Bare Cells

Test	UL	1 Cycle		50 Cycles		100 Cycles		150 Cycles	
	Required?	Passed	Failed	Passed	Failed	Passed	Failed	Passed	Failed
Short Circuit (60°C)	Yes	5	0	3	0	3	0		
Forced Discharge (.8Ax2.5h)	No	5	0						
Forced Discharge (.2Ax12.5h)	Yes			3	0	3	0		
Free Fall	Yes	5	0	3	0	3	0		
Flaming Particles (Fire Exposure)	Yes	5	0	3	0	5	0		
Projectile Test (Fire Exposure)	Yes	5	0	3	0	5	0		
Crush	Yes	5	0	3	0	3	0		
Impact	Yes	5	0	3	0	3	0		
Nail Penetration	No	5	0	3	0				
Overcharge (0.8A)	No	5	0						
Overcharge (0.2A)	Yes			6	0	5	0		
Thermal Exposure (Ramped)	Yes	0	5	5	0	5	0		
Thermal Exposure (Preheated Oven)	No	0	5						
High Rate Charge (2.4A)	No	4	1*						
High Rate Charge (.6Ax3.5h)	Yes	5	0	4	3*	5	1*		

* These failures could be interaction between cells and test equipment.


Nail Penetration
Safety Cell 0181039 - 14
05/18/00
Temperature (°C)
Voltage (V)
Time (min)
Cell Temp
Voltage
0
10
20
30
40
50
60
70
80
0
0.5
1
1.5
2
2.5
3
0
5
10
15
20
25
30
35
40

Core Intellectual Property

- Li-Sulfur Chemistry and Materials
- Advanced Materials and Processing
- Thin Film Technology
- Product Design and Manufacturing

Patent Portfolio Status

- 140 Patents & Applications
- Cover all aspects of materials, product design & manufacturing
- Control of Intellectual Property
- Protection in major battery markets

Battery Patents

- Organo-sulfur polymers
- Cathode compositions
- New separator technology
- Electrolyte compositions
- Anode stabilization and cycleability
- Cell design and engineering
- Cell assembly and manufacturing processes

Moltech Corporation
Li-S Commercialization

- Technology Research & Engineering Development
  - Tucson, AZ
- Production infrastructure in Gainesville, FL
  - Buildings
  - Land
  - Equipment
  - People
- UL Certified Test Laboratory
  - Gainesville, FL
- Electronics Design & Development Laboratory
  - Gainesville, FL

Moltech Corporation
Li-S Commercialization

- Battery Pack Design & Development Laboratory
  - Gainesville, FL
- Battery Pack Assembly
  - Juarez, Mexico
  - Hong Kong
  - UK
  - Malaysia
- Global Marketing/Sales Force

Summary

- Technology advancement from 150 cycles @ 50% rated capacity to 200 cycles@ 80% of rated capacity from January 2000 to September 2000.
- Current Status of development represents 40% of potential for cycle life and energy densities.
- Chemistry today shows safety performance compatible with commercialization.
- Moltech Corporation has all infrastructure required for commercialization.

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Advanced Rechargeable Lithium Batteries

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